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Original Article

Measurement of iron, magnesium and chromium concentrations in the saliva of the patients undergoing fixed orthodontic treatment

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Abstract

Introduction: Stainless steel alloy used in orthodontics has elements such as iron - magnesium and chromium, which may be released due to corrosion in the mouth. The aim of this study was to evaluate the changes of these elements in the saliva of patients undergoing fixed orthodontic treatment.

Methods: In a clinical study with simple non-random sampling, 1ml saliva of 11 patients (7 females and 4 males) who needed fixed orthodontic treatment and had no restorations or crowns were collected. During the fixed orthodontic treatment at successive times (a day, a week, a month, two months and six months), 1 ml of saliva was collected and evaluated for the amount of iron (spectrophotometry), chromium (atomic absorption), and magnesium (spectrophotometry). Bracket, band and wire used in all patients were stainless steel alloy and were manufactured by Dentaurum Company. After sample collection, the data analysis was performed with "Azeri-5" and "10 SPSS" software and repeated measures test.

Results: The mean concentration of iron 66.326±0.541, chromium 0.483±0.324 and magnesium 0.552±293 decreased during the study but these results were not statisticaly significant ($p>0.05$).

Conclusions: Iron, chromium and magnesium concentration do not exceed the standard limits in saliva during orthodontic treatment.

Keywords: Saliva, Chromium, Iron, magnesium, Fixed orthodontic devices, Corrosion.

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Introduction

Fixed orthodontic appliances are made of base metal alloys which are more susceptible to corrosion than noble alloys (1). Common stainless steel alloys used in orthodontics bands and brackets consist of 8% nickel, 17-21% chromium and 64-75% iron (2, 3). These appliances are in long-term contact with the oral environment and can corrode and release elements. The evaluation of releasing potential of orthodontic appliances depends on time. Releasing of cobalt chromium alloys can be measured after a short time in in-vivo studies (4-8). Orthodontic appliances are influenced by friction, pressure and attrition caused by chewing and function of the teeth in the oral environment and these factors can effect on elements releasing (9).

Corrosion occurs due to strong electrical activity of saliva. Under certain conditions, an alloy may resist to corrosion, but under small changes (such as PH changes of the mouth from 7 to 5), resistance can be lost (10).

Releasing of metal ions does not directly depend on the amount of each metal in the alloy and some alloys are typically more resistant to corrosion (2). Corrosion causes the release of some elements which may cause biological problems after being absorbed by the body (11). One of these problems based on International Agency for Research on Cancer (IARC) evaluation is carcinogenesis and allergic potential of metals such as iron, nickel and chromium (12-15).

It is demonstrated that the released metals of current alloys never reach toxic doses because of their structure. Also, fixed orthodontic appliances in oral environment release measurable amounts of nickel and chromium, but this incensement do not reach toxic levels in saliva and serum (16).

Also fixed orthodontic appliances during 2 months of treatment, have no significant effects on nickel and chromium content of saliva (17). Overall, the levels of these metals are very low (lower than 2/0 PPM) (18, 19).

Methods

In this study, 11 referred patients by an orthodontic specialist who had skeletal anomalies and needed fixed orthodontic treatments were selected. These patients had no history of orthodontic treatment (fixed or removable) before, and did not have any restoration or porcelain crown. 1 ml saliva sample was taken from each patient into test tubes, then the tube heads were sealed with paraffin and were stored at-20° freezer before analysis. Sampling was performed in the following six steps: before bonding of orthodontic appliances, one day one week after and six months after bonding of orthodontic appliances.

The amount of iron and magnesium was measured by spectrophotometry and the amount of chromium was measured by atomic absorption. All orthodontic appliances were manufactured by Dentaurum Company. After data collection, data analysis was performed by SPSS 10.5 software and repeated measures analysis.

Results

In this study, concentration of iron, chromium and magnesium was measured. Mean of magnesium, iron and chromium concentration and standard deviation (SD) in saliva of patients undergoing fixed orthodontic treatment before and up to 6 months after bonding of orthodontic brackets (microgr / dl) has been shown in table 1.

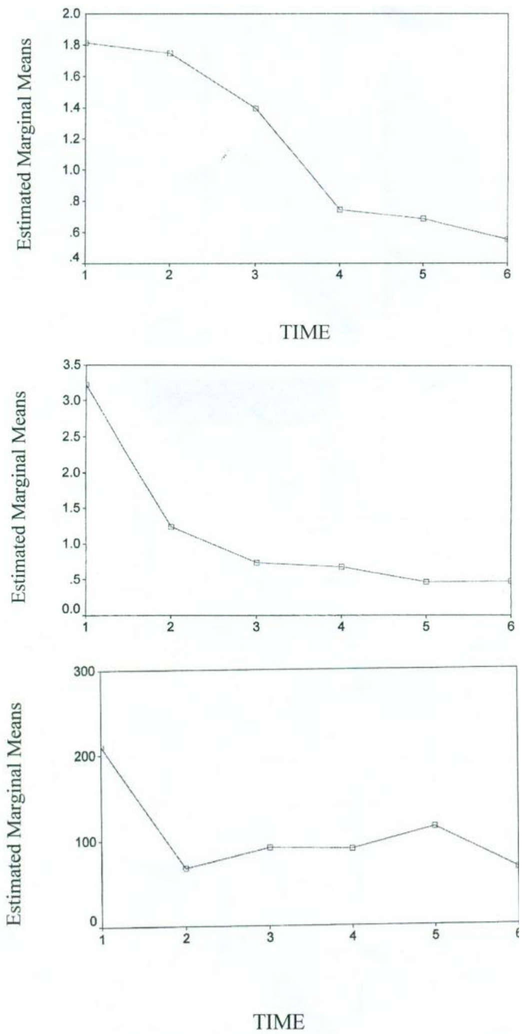

Figure 1: A) Mean concentration of magnesium, B) Iron and chromium, C) in saliva of patients treated with fixed orthodontic treatment before bonding and 6 months after.

1. Before bonding 2. 1 day 3. 1 week
4. 1 month 5. 2 month 6. 6 months

Table 1: Mean of magnesium, iron and chromium concentration and standard deviation (SD) in saliva of patients undergoing fixed orthodontic treatment before and up to 6 months after bonding of orthodontic brackets (microgr / dl)

Time/Element	Before bonding Mean±SD	1 Day Mean±SD	1 Week Mean±SD	1 Month Mean±SD	2 Months Mean±SD	6 Months Mean±SD	pvalue
Magnesium	0.552±0.293	0.685±0.40	0.743±0.514	1.395±0.471	1.747±0.415	1.815±0.378	0.000
Iron	66.326±0.541	114.800±0.108	89.544±0.072	91.546±0.007	68.102±0.647	210.311±0.993	0.000
Chromium	0.483±0.324	0.471±0.238	0.685±0.624	0.741±0.714	1.240±1.244	3.224±0.777	0.013

Discussion

The present study demonstrated that in patients undergoing orthodontic treatment, orthodontic appliances made of stainless steel alloys release elements such as iron, magnesium, cobalt and chromium into the oral environment due to corrosion process. A notable point which was seen in this context was that some elements such as magnesium and iron had an approximately uniform reduction of concentration during the study, but after an initial decrease in iron concentration, there was a relative increase in the first week and second month which could be due to corrosion of brackets and the release of this element in the oral environment. Similar to the other two elements, final concentration after 6 months was far less than the initial concentration, although its cause was unclear, but this phenomenon could possibly happen due to diet changes and the biological layer after bonding brackets.

Based on conducted studies, metal ion release from orthodontic brackets and other appliances, containing more than 18% of elements such as nickel and chrome alloys, (stainless steel) (2, 3) is a trivial matter. Increasing concentrations of chromium and cobalt in saliva from electro-chemically inactive alloys was stated by Erichsen (6).

Nils et al. (18) also reported the immediate release of nickel and iron after placement of fixed orthodontic appliances on the teeth, which was very little in comparison with input of these elements through nutrition (about less than 2.0PPM). Staffolani et al. (19) revealed that the daily release rate of metal ions from oral appliances in quite acidic environment is very little compared with the absorption of these elements through nutrition.

They can never reach toxic levels and become anxious, however these results are consistent with the result of our study about iron. We encountered increase of iron concentration in saliva during the first week after bracketing. In the current study, concentration of magnesium, iron and chromium metal ions in the saliva decreased in all time sections after bonding orthodontic brackets compared to the initial concentration (before attaching brackets) and this reduction was statistically significant, it is evident that this was also dependent on diet.

Eliades (20) stated that the potential of releasing elements from orthodontic alloys is a time-dependent phenomenon, in this sense, over time releasing elements in saliva can be changed. Cortizo et al. (21) concluded that all alloys used in orthodontic appliances were biocompatible. Faccioni (22) concluded that released nickel and cobalt from fixed appliances could destruct DNA of epithelial cells. Bacher and Koppenbury (23) reported the increased concentrations of nickel and chromium 3 days after application of fixed orthodontic appliances. After 3 months, there was no fixed pattern of increase or reduction. Their results were inconsistent with the present study, since in our study a significant reduction was observed in the concentration of all elements especially in chromium. Ozer et al. (17) concluded that nickel and chromium concentrations in saliva did not increase significantly after 2 months of receiving orthodontic treatment, these results were completely consistent with the current study. Schiff (24) demonstrated that orthodontic appliances in mouth will release measurable amounts of chromium and nickel elements in saliva, which do not reach toxic levels (more than 2 microgr/dl).

According to Eliades (20), the potential of releasing elements from orthodontic alloys is a time-dependent phenomenon; it means that the concentration of elements changes in saliva during that time.

Hwang et al. (4) concluded that during 3 months with increasing immersion time of orthodontic devices in artificial saliva metal ions releasing reduces which was completely similar to our results about chromium and magnesium. According to Kerosuo et al. (3) the concentration of released elements did not show significant changes (increase or decrease) during the first month after bonding brackets.

Erichsen (6) described that galvanic reaction between brackets and steel wires could lead to increased susceptibility to corrosion in orthodontic appliances in clinical conditions.

Conclusion: The concentration of studied elements (iron, chromium, magnesium) is almost constant after 6 months of bracketing.

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